

Excitation functions of baryon anomaly and freeze-out properties at RHIC-PHENIX

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Abstract. The intermediate p_T region (2 - 5 GeV/ c) in central Au+Au collisions at RHIC has a rich physics content. The (anti)proton to pion ratio at the intermediate p_T gives us a powerful tool to investigate the bulk properties of the hot and dense matter created at RHIC and their hadronization processes. We present the preliminary results of identified charged hadron spectra at the lower beam energies at RHIC. The excitation function of (anti)proton to pion ratios from SPS to RHIC are shown. We also discuss the onset of the baryon enhancement at the high energy heavy ion collisions.

1. Introduction

One of the most surprising observations at the Relativistic Heavy Ion Collider (RHIC) is a particle type dependence of hadron yield suppression at the intermediate transverse momentum p_T (2 - 5 GeV/ c) [1, 2]. In Au+Au central collisions at $\sqrt{s_{NN}} = 200$ GeV, yields for mesons are largely suppressed [3] with respect to the yields in proton-proton collisions at the intermediate p_T , while those for baryons are not suppressed. The Cronin effect [4, 5] alone does not explain the observed large baryon yield in central Au+Au collisions [6]. This phenomena is called "Baryon Anomaly (or Enhancement) at RHIC". To explain the data, many theoretical models have been proposed. Among those, a quark recombination process [7] is now believed to be one of the dominant hadronization processes at the intermediate p_T in central Au+Au collisions at RHIC, with the support by the experimental data of the nuclear modification factor R_{AA} and the elliptic flow for ϕ meson [8, 9]. Now the key questions are the onset effect of baryon enhancement and how it evolves as a function of beam energy. In order to answer these questions, the lower energy beam data in Au+Au/Cu+Cu/p+p collisions were taken during the successive RHIC runs from 2004 to 2006 by the PHENIX experiment. In this paper, we present the preliminary results of p_T spectra for identified charged particles ($\pi^\pm/p/\bar{p}$) in Au+Au/Cu+Cu/p+p collisions at $\sqrt{s_{NN}} = 62.4$ GeV and Cu+Cu collisions at 22.5 GeV from PHENIX. The centrality and beam energy dependences of $p(\bar{p})/\pi$ ratio are

[‡] For the full list of PHENIX authors and acknowledgments, see Appendix 'Collaborations' of this volume.

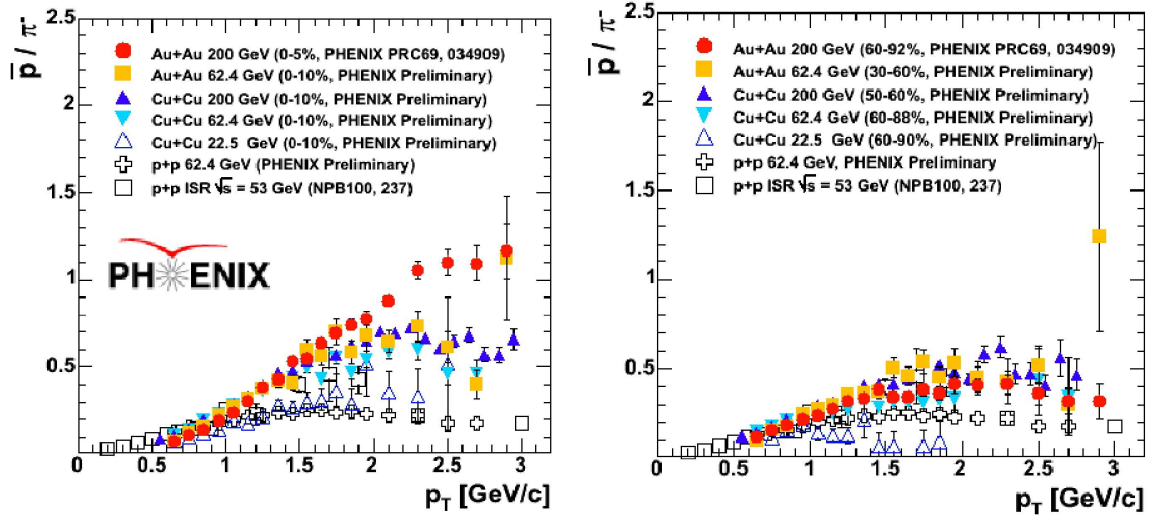


Figure 1. Compilation of \bar{p}/π^- ratios as a function of p_T for central (left) and peripheral (right) collisions.

presented. We also discuss a possible onset effect of the baryon enhancement at RHIC energy.

2. Data analysis and results

Figure 1 shows the compilation of \bar{p}/π^- ratios as a function of p_T , which includes the PHENIX data points in Au+Au/Cu+Cu at $\sqrt{s_{NN}} = 200$ GeV [1, 10], Au+Au/Cu+Cu/p+p at 62.4 GeV, and Cu+Cu at 22.5 GeV. The ISR data in p+p at $\sqrt{s} = 53$ GeV [11] is also shown for the comparison, and it agrees with the newly measured \bar{p}/π^- ratio in p+p at 62.4 GeV. No weak decay feeddown correction is applied for proton and antiproton yields. More details on the data analysis method can be found in [12]. For the central collisions (Fig. 1, left panel), the \bar{p}/π^- ratios at the intermediate p_T in Au+Au/Cu+Cu at 200/62.4 GeV are larger than the values in p+p, except for the central Cu+Cu collisions at 22.5 GeV, which is consistent with the p+p values. For the peripheral collisions (Fig. 1, right panel), all of the ratios are converging on the ratios in p+p collisions.

Figure 2 and Figure 3 show the $\sqrt{s_{NN}}$ dependence of p/π^+ and \bar{p}/π^- ratios respectively, from SPS $\sqrt{s_{NN}} = 17.3$ GeV [13] to the top RHIC energy 200 GeV in Au+Au/Cu+Cu for the central collisions at the intermediate p_T (2.0 - 2.2 GeV/c). The data points for p+p are also shown in these plots. In general, p/π^+ (\bar{p}/π^-) ratio decreases (increases) as a function of $\sqrt{s_{NN}}$, respectively. The larger p/π^+ ratios for the lower beam energies can be understood by the influence of the incoming nucleons from the beams (a baryon transport at the midrapidity). On the other hand, \bar{p}/π^- ratio can be used as a measure for the baryon enhancement, because antiprotons are “produced

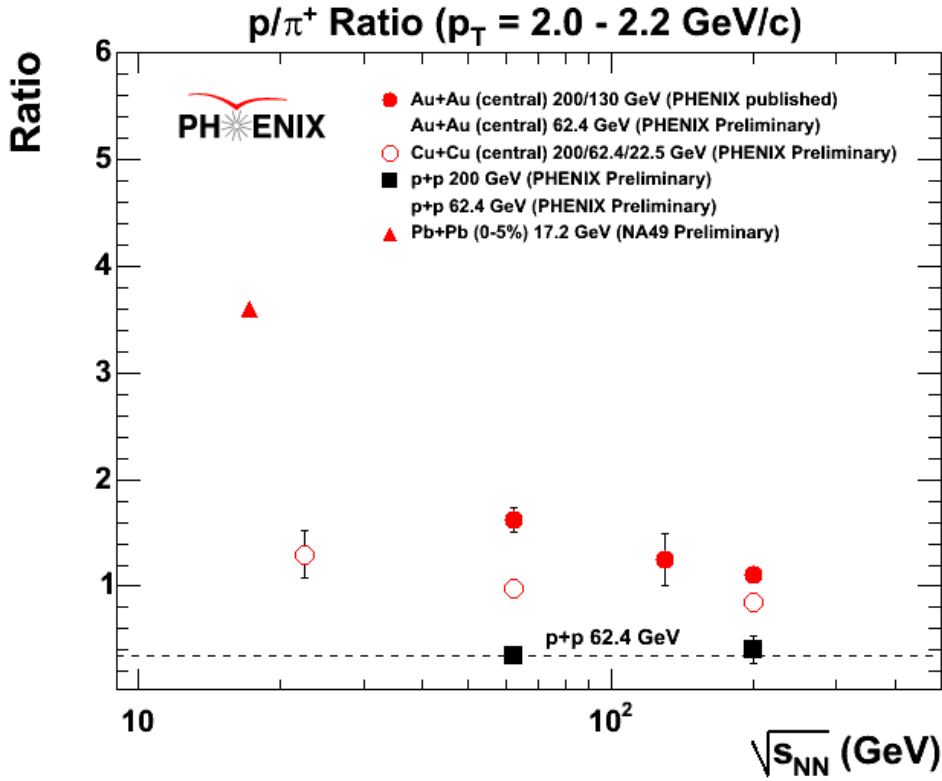


Figure 2. Beam energy dependence of p/π^+ ratio for the central collisions at the intermediate p_T (2.0 - 2.2 GeV/c). The dashed line is the value for p+p at 62.4 GeV.

particles". As shown in Figure 3, the \bar{p}/π^- ratio in Cu+Cu 22.5 GeV is consistent with both p+p measurements and the SPS Pb+Pb central collision data. It suggests there is no baryon enhancement at 22.5 GeV in Cu+Cu collisions. An onset effect of baryon enhancement could be seen in between $\sqrt{s_{NN}} = 22.5$ to 62.4 GeV. To conclude, the high statistics data with the heavier collisions system like Au+Au at around 22.5 GeV is necessary in the future RHIC run, as well as the more extensive beam energy scan in the RHIC-II program.

3. Summary

In summary, we have measured p/π^+ and \bar{p}/π^- ratios in Au+Au, Cu+Cu, and p+p collisions at $\sqrt{s_{NN}} = 62.4$ GeV, and Cu+Cu at 22.5 GeV. In the central Cu+Cu collisions at 22.5 GeV, \bar{p}/π^- ratio at the intermediate p_T is consistent with the values in both p+p collisions and Pb+Pb central collision, and it suggests that there is no baryon enhancement at 22.5 GeV Cu+Cu collisions and the onset of baryon enhancement might exist in between $\sqrt{s_{NN}} = 22.5$ to 62.4 GeV. These p/π^+ and \bar{p}/π^- ratios may give a further constraint to the hadronization process in the recombination models at the beam energies from SPS to RHIC.

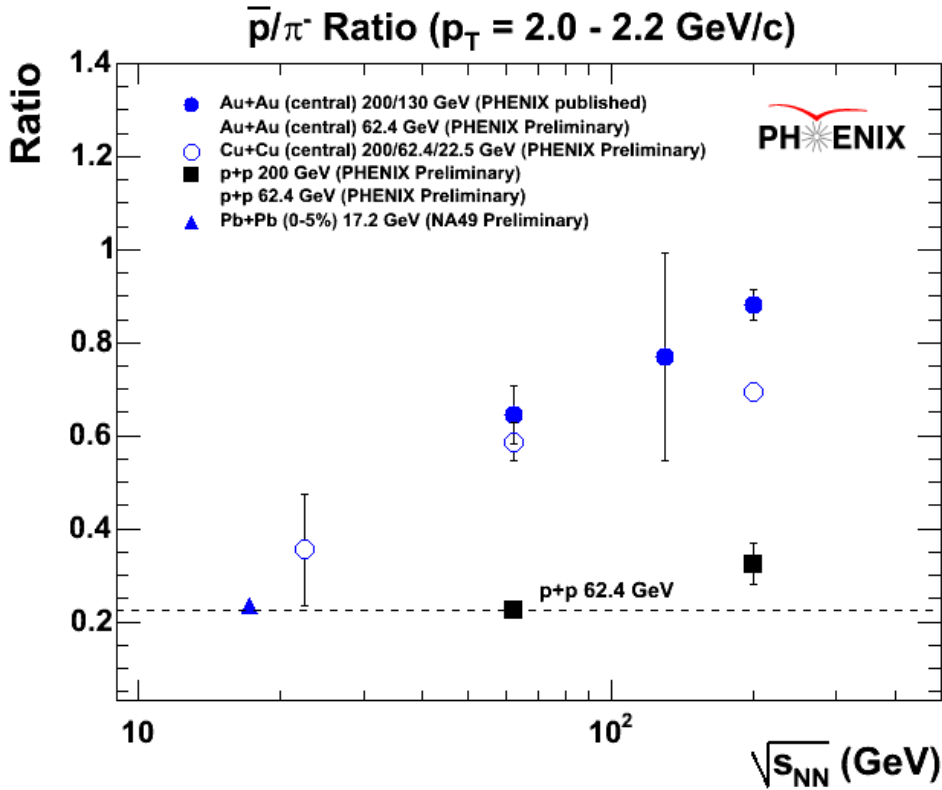


Figure 3. Beam energy dependence of \bar{p}/π^- ratio for the central collisions at the intermediate p_T (2.0 - 2.2 GeV/c). The dashed line is the value for p+p at 62.4 GeV.

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